TASK ANSWERS 9 UNITS

0.1

1. (a) 2.45×10^4

(b) 3.56×10^2

(c) 9.85×10^{-4}

(d) 2.22×10^{-1}

(e) 1.22×10^4

2. (a) 4200

(b) 0.000215

(c) 0.00000314

(d) 922000

(e) 957

0.2

1. (a) 0.0186

(b) 0.852

(c) 331407.68

(d) 74.97

(e) 15.4195

2. (a) 3 miles = 4828.03 m

(b) 25 lbs = 11.3398 kg

0.3

1. (a) -260

(b) 1663

2. When determining *change*, one degree Celsius is the same as (equivalent to) one Kelvin.

0.4

1. (a) 4

(b) 2

(c) 4

(d) 2

(e) 2

(f) 4

2. (a) 809

(b) 40

(c) 92.9

(d) 67.64

(e) 12.7

(f) 3

0.5

1. (a) Y

(b) Y

0.6

1. (a) p = 82, e = 82, n = 128

(b) p = 16, e = 16, n =18

2. (a) 20

(b) 10

0.7

1. (a) Sodium chloride

(b) Strontium oxide

(c) Aluminum nitride

(d) Barium chloride

(e) Potassium oxide

(f) Copper(II) oxide

(g) Copper(I) oxide

2. (a) Mg_3N_2

(b) $BaBr_2$

(c) AlP

(d) KI

(e) LiCl

(f) NaF

(g) $SnBr_4$

0.8

1. (a) NH_4NO_3

(b) $CuBr_2$

(c) $CuBr$

(d) $Zn(HSO_4)_2$

(e) $Al_2(SO_4)_3$

(f) $NaClO_4$

(g) $Cu(IO_2)_2$

2.(a) Sodium nitrate

(b) Potassium manganate(VII) (potassium permanganate)

(c) Calcium ethandioate (calcium oxalate)

(d) Copper(II) sulfate

(e) Copper(I) sulfate

(f) Potassium nitrite

(g) Lithium perchlorate

0.9

1. (a) N_2O_4

(b) PCl_5

(c) IF_3

(d) NO_2

(e) H_2O

2. (a) Dinitrogen pentoxide

(b) Phosphorus trichloride

(c) Sulfur hexafluoride

(d) Water (dihydrogen monoxide)

(e) Dichlorine monoxide

1.1

1. (a) FeO

(b) Fe_2O_3

(c) Fe_3O_4

2. CH, CH_2, CH_3O, $C_3H_6O_2$ - all cannot be simplified further.

3. They are not the same sample, not all can be pure.

1.2

1. CH

2. C_6H_6

3. Yes, BUT also consistent with an impurity that has any amount of C that is less than 92.31 since the % of C has gone down.

1.3

1. 58.5 g

2. 3.5 moles

3. 0.00234 moles

4. 0.523 moles

5. Answers here are the number of moles multiplied by Avogadro's number (6.02×10^{23}), remembering that for example, NaCl has both Na^+ ions and Cl^- ions and that $CuBr_2$ contains twice as many Br^- ions as Cu^{2+} ions, etc.

1.4

1. (a) No, different elements

(b) Yes, same element with different numbers of neutrons therefore different masses.

2. p = 17, e = 17, n = 18.

1.5

1. 20.18

2. 85.58

3. 69.76

1.6

1. 35.5; $Cl^{37} = 25\%$, $Cl^{35} = 75\%$

2. 5 peaks. Two of the same height at 79 and 81, and three at m/z values of 158, 160 and 162, with the 160 peak twice the size of the 158 and 162 which would be identical. Think of the bromine diatomic molecule as being made up of Br atom "x", and Br atom "y".

Combo a. x = 79 and y = 79, when added = 158

Combo b. x = 81 and y = 79, when added = 160

Combo c. x = 79 and y = 81, when added = 160

Combo d. x = 81 and y = 81, when added = 162

160 is twice as likely as 158 and 162, so has a peak twice the height.

3. 47.92

4.(a) That there are three isotopes of Mg

(b) (i) That it is the isotope with the greatest abundance

(ii) 24.3

1.7

1	$1s^1$
2	$1s^2$
3	$1s^2\,2s^1$
4	$1s^2\,2s^2$
5	$1s^2\,2s^2\,2p^1$
6	$1s^2\,2s^2\,2p^2$
7	$1s^2\,2s^2\,2p^3$
8	$1s^2\,2s^2\,2p^4$
9	$1s^2\,2s^2\,2p^5$
10	$1s^2\,2s^2\,2p^6$
11	$1s^2\,2s^2\,2p^6\,3s^1$
12	$1s^2\,2s^2\,2p^6\,3s^2$
13	$1s^2\,2s^2\,2p^6\,3s^2\,3p^1$
14	$1s^2\,2s^2\,2p^6\,3s^2\,3p^2$
15	$1s^2\,2s^2\,2p^6\,3s^2\,3p^3$
16	$1s^2\,2s^2\,2p^6\,3s^2\,3p^4$
17	$1s^2\,2s^2\,2p^6\,3s^2\,3p^5$
18	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6$
19	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1$
20	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2$
21	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^1$
22	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^2$
23	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^3$
24	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^5$
25	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^5$
26	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^6$
27	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^7$
28	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$
29	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^{10}$
30	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}$
31	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^1$
32	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^2$
33	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^3$
34	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^4$
35	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^5$
36	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^6$

1.8

1. (a) [Ar] $4s^1\ 3d^{10}$

(b) [Ar] $4s^2\ 3d^7$

(c) [Ar] $4s^2$

(d) [He] $2s^2\ 2p^2$

(e) [Ne] $3s^2\ 3p^6$

(f) [Ar] $4s^2\ 3d^{10}\ 4p^1$

2. (a) [He] $2s^2\ 2p^6$ OR [Ne]

(b) [Ne] $3s^2\ 3p^6$ OR [Ar] OR [Ar] $4s^0$

(c) [Ne] $3s^2\ 3p^6$ OR [Ar]

(d) [He] $2s^2\ 2p^6$ OR [Ne]

(e) [He] $2s^2\ 2p^6$ OR [Ne]
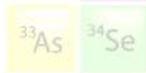
1.9

1s	2s	2p	3s	3p	3d	4s	4p	
↑↓	↑↓	↑ ↑						C
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓		↑↓		Ca
↑↓	↑↓	↑↓ ↑↓ ↑↓						Ne
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	↑ ↑ ↑ ↑ ↑	↑		Cr
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑	Ga
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓		↑		K
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓ ↑↓ ↑↓ ↑ ↑	↑↓		Ni
↑↓	↑↓	↑ ↑ ↑						N
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	↑		↑↓	Sc
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	Kr

1.10

1. (a) There are 4 occupied sub-shells

(b) $1s^2\ 2s^2\ 2p^6\ 3s^1$ in decreasing order of peak energy (i.e., the $1s^2$ electrons are the most difficult to remove)

(c) $2p^6$

2. (a) Three

(b) $1s^2$

(c) $2p^6$

3. Aluminum. It is the first element to have electrons in the 3p sub-shell. The 3p sub-shell is the fifth sub-shell to be filled

1.11

1. (a) Decreases. Greater shielding outweighs greater number of protons
(b) Increases. Same shielding, more protons

2. (a) Group 1
(b) Group 2
(c) It only has three electrons

3. Energy required to remove one mole of electrons from one mole of gaseous atoms to form one mole of singly charge ions

Number of protons and the amount of shielding (distance form the nucleus).

4. (a) RO
(b) Less mutual repulsion of electrons but same number of protons

5. Increases. Same shielding, more protons

6. Zero shielding, electrons directly adjacent to the nucleus

1.12

Isoelectronic, BUT different numbers of protons. Largest number of protons = greatest attraction = smallest species

2.1

1.

Na^+, Cl^-; NaCl

Ca^{2+}, Cl^-; $CaCl_2$

Fe^{3+}, Br^-; $FeBr_3$

Na^+, O^{2-}; Na_2O

2.

NaCl. The smaller radius of the chloride ion when compared to the bromide ion allows the ions in NaCl to get closer to one another than in NaBr, and therefore the Coulombic attraction is greater.

2.2

Molecule or ion	Lewis Structure
F_2	F single bonded to F with each F atom having 6 other electrons around it to complete the octet
O_2	O double bonded to O with each O atom having 4 other electrons around it to complete the octet
N_2	N triple bonded to N with each N atom having 2 other electrons around it to complete the octet
HCl	H single bonded to Cl with the Cl atom having 6 other electrons around it to complete the octet
HF	H single bonded to F with the F atom having 6 other electrons around it to complete the octet
H_2O	2 H atoms single bonded to central O with the O atom having 4 other electrons around it complete the octet
NH_3	3 H atoms single bonded to central N with the N atom having 2 other electrons around it complete the octet
CBr_4	4 Br atoms single bonded to central C with each Br atom having 6 other electrons around it to complete the octet
PF_5	5 F atoms single bonded to central P with each F atom having 6 other electrons around it to complete the octet
PCl_6^-	6 Cl atoms single bonded to central P with each Cl atom having 6 other electrons around it to complete the octet
NH_4^+	4 H atoms single bonded to central N

2.3

Molecule or ion	Lewis Structure	Shape	Bonding pairs around central atom	Non-Bonding pairs around central atom	Bond Angles
PCl_6^-	6 Cl atoms single bonded to central P with each Cl atom having 6 other electrons around it to complete the octet	Octahedral	6	0	90°
ICl_3	3 Cl atoms single bonded to central I with each Cl atom having 6 other electrons around it to complete the octet PLUS 2 lone pairs on central I	T-shaped	3	2	Approx. 90°
BrF_5	5 Cl atoms single bonded to central Br with each Cl atom having 6 other electrons around it to complete the octet PLUS 1 lone pair on central Br	Square Pyramid	5	1	Approx. 90°
SO_3^{2-}	3 O atoms single bonded to central S with each O atom having 6 other electrons around it to complete the octet PLUS 1 lone pair on central S	Trigonal pyramid	3	1	107.5°
CH_4	4 H atoms single bonded to central C	Tetrahedral	4	0	109.5°
NH_4^+	4 H atoms single bonded to central N	Tetrahedral	4	0	109.5°
ICl_4^-	4 Cl atoms single bonded to central I with each Cl atom having 6 other electrons around it to complete the octet PLUS 2 lone pairs on central I	Square Planar	4	2	90°
SO_2	2 O atoms bonded to central S atom (one double bonded, one single bonded with possibility of resonance) with each O atom having other electrons around it to complete the octet PLUS 1 lone pair on central S	V-shaped	2	1	Slightly less than 120°

2.4

The structure to the right has the most favorable formal charges (zero on all atoms), so is the preferred structure.

3.1

1. (a) The LDFs are approximately the same.

(b) Butan-1-ol has additional hydrogen bonding as an IMF that dramatically increases the attractions between molecules of the alcohol, thus significantly raising the boiling point when compared to pentane

2. Both molecules have LDFs, but HCl also has dipole-dipole interactions

Despite dipole-dipole interactions generally being stronger than LDFs, in instances where the molecules are large (larger surface area and more electrons), the collective interactions created by many LDFs can outweigh the stronger dipole-dipole interactions to give a greater attraction between the molecules. In this case, the larger Cl_2 molecules have LDFs that are collectively stronger than the LDFs and dipole-dipole interactions in the much smaller, HCl

3. Increase in boiling points since LDFs increase with surface area and number of electrons and polarizability.

3.2

A: Ionic - poor conductor when solid because ions cannot move. High m.p., means strong, ionic bonds. Will conduct when liquid when the ions are free to move.

B: Metallic - high m.p., always a good conductor with free moving electrons.

C: Molecular - never a good conductor (no charged particles to act as charge carriers. Low m.p. due to weak IMF's.

3.3

1. 0.864 atm

2. 1.09 atm

3.4

1. 0.272 L

2. 422 mL

3.5

1. 10.4 L

2. 288 K

3.6

1. 8.21 L

2. 37.4 L

3.7

1. 318 K

2. 247 K

3.8

1. 0.435 mols

2. 266.4 g mol^{-1}

3.9

1. 0.0255 mols

2. 717.6 kPa (Apply P1V1 = P2V2, Boyle's law for EACH gas, then add the new P's (Dalton's)).

3.10

1. (a) 1363 ms^{-1}

(b) 482 ms^{-1}

(c) 183 ms^{-1}

2. (a) 1419 ms^{-1}

(b) 502 ms^{-1}

(c) 191 ms^{-1}

3. u_{rms} is lower at lower temperatures and lower with larger molar masses

3.11

1. 0.192 L (192 mL)

2. 0.192 L (192 mL)

3. 1.75 L

4. Add approx. 250 mL of distilled/deionized water to a 500 mL volumetric flask. Slowly and carefully add 192 mL of nitric acid using a buret. Make up to the mark with distilled/deionized water. Wear safety goggles, chemical resistant gloves and lab coat or apron at all times, and only ever add small amounts of concentrated acid to large volumes of water. Diluting concentrated acid can be a highly exothermic process, and safe dilution is essential. The use of accurately graduated glassware such as burets, pipets and volumetric flasks, ensure the accuracy of the dilution.

4.1

1. (a) $H_2 + CuO \rightarrow Cu + H_2O$

(b) $2C + O_2 \rightarrow 2CO$

(c) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

2. (a) $Ca + 2H_2O \rightarrow H_2 + Ca(OH)_2$

(b) $2Cu + O_2 \rightarrow 2CuO$

(c) $4Na + O_2 \rightarrow 2Na_2O$

(d) $Fe + 2HCl \rightarrow FeCl_2 + H_2$

(e) $2Fe + 3Br_2 \rightarrow 2FeBr_3$

(f) $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

(g) $Na_2CO_3 + 2HI \rightarrow 2NaI + CO_2 + H_2O$

(h) $CuCO_3 \rightarrow CuO + CO_2$

(i) $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

(j) $H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

(k) $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

(l) $4Al + 3O_2 \rightarrow 2Al_2O_3$
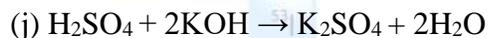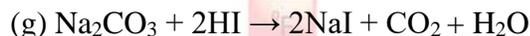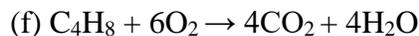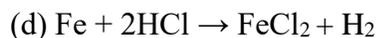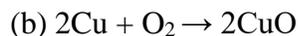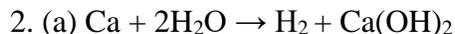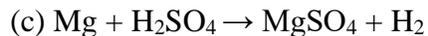
4.2

1. (a) Formation of steam (the reaction is sufficiently exothermic that it produces enough energy to convert the water produced to a gas)

(b) $2H_2 + O_2 \rightarrow 2H_2O$

(c) Reactants and products appear in the correct ratios (i.e., the equation is balanced according to the answer given in (b). Oxygen, hydrogen and water are all consistently represented by the black and white circles (i.e., the ratio of atoms in each case are consistent with the known formulas for the substances)

4.3

1. When water boils the process can be summarized as; $H_2O_{(l)} \rightarrow H_2O_{(g)}$. As such, no new substances are formed, there is only a change of state, and only *inter*molecular forces are broken
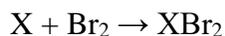
2. When water is broken down into its elements, the process can be summarized by the equation, $2H_2O \rightarrow 2H_2 + O_2$. As such, new substances are formed, and intra bonds (covalent) are broken

4.4

1. (a) 3.24 g

(b) 76.5 g

2. (a) 1:1

$X + Br_2 \rightarrow XBr_2$

(b) Calcium (molar mass 40 gmol^{-1}) that is consistent with being a group 2 element, and forming a 2+ ion, and reacting in the ratio in the equation in (a)

3. 34.98 g

4. $1Cu^{2+}:2I^-$

5. 0.142 M

6. 0.981 g

7. 0.05 L or 50 mL

4.5

1. 27.7 g

2. 1.12 L

3. 83.7 gmol^{-1}

4.6

Chlorine is limiting.

1.42 moles of product (SCl_6) which is equal to 348 g

157 g of excess reactant (S) left over
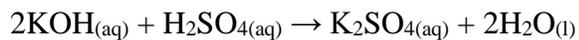
4.7

88.9%

4.8

$C_5H_6O_3$

4.9

1. x = 6

2. Heating until the mass does not change anymore, i.e., heating until all of the water has been driven off and the salt is completely dehydrated (anhydrous)

4.10

1.14 M

4.11

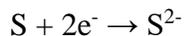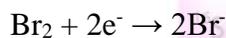$2KOH_{(aq)} + H_2SO_{4(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$

$2K^+_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + SO_4{}^{2-}_{(aq)} \rightarrow 2K^+_{(aq)} + SO_4{}^{2-}_{(aq)} + 2H_2O_{(l)}$

$2H^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$
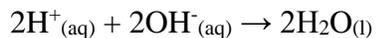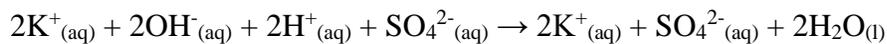
4.12

1. (a) +6

(b) -0.5

(c) -3

(d) +2

(e) +3

2. (a) $Ca + S \rightarrow CaS$

$Ca \rightarrow Ca^{2+} + 2e^-$

$S + 2e^- \rightarrow S^{2-}$

(b) $2Al + 3Br_2 \rightarrow 2AlBr_3$

$Al \rightarrow Al^{3+} + 3e^-$

$Br_2 + 2e^- \rightarrow 2Br^-$

(c) $4Al + 3O_2 \rightarrow 2Al_2O_3$

$Al \rightarrow Al^{3+} + 3e^-$

$O_2 + 4e^- \rightarrow 2O^{2-}$

3. (a) $IO_3^- + 5e^- + 6H^+ \rightarrow \frac{1}{2}I_2 + 3H_2O$

$5I^- \rightarrow 2\frac{1}{2}I_2 + 5e^-$

$IO_3^- + 6H^+ + 5I^- \rightarrow 3H_2O + 3I_2$

(b) $I_2 + 2e^- \rightarrow 2I^-$

$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$

(c) $Br_2 + 2e^- \rightarrow 2Br^-$

$2I^- \rightarrow I_2 + 2e^-$

$Br_2 + 2KI \rightarrow I_2 + 2KBr$

(d) $2MnO_4^{2-} \rightarrow 2MnO_4^- + 2e^-$

$MnO_4^{2-} + 2e^- + 4H^+ \rightarrow MnO_2 + 2H_2O$

$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$
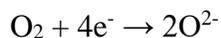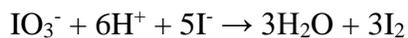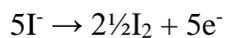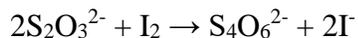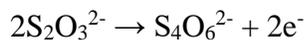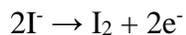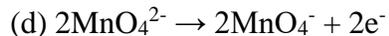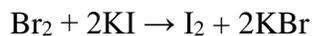
(e) NOT REDOX (all oxidation states the same) so no half reactions required

$2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$
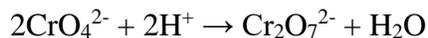
4.13

1.(a) MgO

(b) It goes up, side oxygen is added.

2. (a) Decomposition.

(b) $CaCO_3 \rightarrow CaO + CO_2$
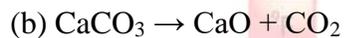
(c) Mass of $CaCO_3$ = 30.46 - 24.56 = 5.90 g

Mass of CO_2 = 30.46 - 27.86 = 2.6 g

Moles of $CaCO_3$ = 5.90/100 = 0.0590

Moles of CO_2 = 2.6 /44 = 0.059

i.e., 1:1 ratio which agrees with the equation

4.14

0.0754 M

4.15

$x = 12$

Method

1. Calculate the moles of manganate(VII) by multiplying the concentration by the volume.

2. Realize (and THIS is really the quantum leap of intelligence) that in that huge, double salt, the thing that is getting oxidized is Fe^{2+}, so therefore the missing half reaction is, $Fe^{2+} \rightarrow Fe^{3+} + e^-$.

3. Combine the half reaction in 2. above with the manganate(VII) half reaction to get the reacting ratio ($5Fe^{2+}:1MnO_4^-$) and therefore get the moles of Fe^{2+} in the 25.0 mL sample from the answer to 1., above.

4. Multiple the answer in 3. above by 10 to get moles of Fe^{2+} in 250 mL sample and realize that the moles of Fe^{2+} also equals the moles of the WHOLE salt (since in 1 mole of the whole salt there is 1 mole of Fe^{2+}, i.e., it's a 1:1 ratio).

5. Calculate the molar mass of the whole salt by dividing grams (given in the Q) by moles calculated in 4. above.

6. Subtract all of the molar masses of the pieces of the salt that we know (N, H, Fe, S, O) to leave the mass of H_2O.

7. The answer to 6. above should be divisible nicely by 18, i.e., should give you an integer value for x.

4.16

(a) $Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2(s)}$

(b) $Ba^{2+}_{(aq)} + S^{2-}_{(aq)} + Ni^{2+}_{(aq)} + SO_4^{2-}_{(aq)} \rightarrow NiS_{(s)} + BaSO_{4(s)}$

(c) No reaction

(d) $Al^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Al(OH)_{3(s)}$

4.17

(a) AgCl

(b) 0.002 mols

(c) 0.002 mols

(d) 0.0709 g

(e) 39%

(f) The mass of precipitate would be too large, making the moles of AgCl too large, making the moles of chloride too large, making the mass of chloride too large, making the calculated % by mass too large.

5.1

(a) They are both catalysts since they both increase the rate of reaction, and at the end of the experiment they are regenerated, i.e., are unchanged

(b) In each case the H_3O^+ and the OH^- are regenerated

5.2

1. The total mass of the chips was the same in experiment, since the total volume of gas produced in each experiment was the same. (The acid was in excess)

2. The small chip experiment was complete between 120 and 135 seconds. The large chip experiment was complete between 150 and 165 seconds. The reaction is complete when no more gas is produced which is illustrated on the graph when the line plateaus

3. mL/s (many other possible answers would work)

4. $2HCl_{(aq)} + CaCO_{3(s)} \rightarrow CO_{2(g)} + H_2O_{(l)} + CaCl_{2(aq)}$

5. When solids are present, one of the factors which affects the rate of a chemical reaction is the surface area of the solid. The reaction between the solution and the solid takes place at the surface of the solid, so a greater surface area offers more sites for collision, and therefore a faster reaction. Small chips have a larger surface area than the same mass of larger chips, so the reaction is faster with the smaller sized solid

6. Mass the chips using the balance, use the measuring cylinder to measure the volume of the acid, and then use the gas syringe to collect the carbon dioxide from the reaction occurring in an Erlenmeyer flask. See this for an example of the set up

7. Heat the acid solution to varying temperatures OR change the concentration of the acid to varying concentrations, *each time keeping all other variables the same*

5.3

V_2O_4 is the intermediate, V_2O_5 is the catalyst

5.4

1. Rate = k $[X]^2$

Order w.r.t $[Y] = 0$

Total order = 2 + 0 = 2

k = 40000 M^{-1} min^{-1}

2. Rate = k $[A][B]$

Total order = 1 + 1 = 2

k = 8000 M^{-1} s^{-1}

5.5

1.

By comparing experiments 2 and 1, we find;

$\dfrac{Rate\ 2 = 2.00 = k\ [0.01000]^x[0.0250]^y}{Rate\ 1 = 1.00 = k\ [0.00500]^x[0.0250]^y}$	Where x and y are the orders with respect to [A] and [B] respectively, and k is the rate constant.

This allows the simplification of the expression to read;

$\dfrac{Rate\ 2 = 2.00 = k\ [0.01000]^x[0.0250]^y}{Rate\ 1 = 1.00 = k\ [0.00500]^x[0.0250]^y} = 2 = 2^x$	Therefore x = 1, i.e., the order with respect to [A] is 1.

Repeat the process to investigate the order with respect to [B] by comparing experiments 1 and 3;

$\dfrac{Rate\ 1 = 1.00 = k\ [0.00500]^x[0.0250]^y}{Rate\ 3 = 0.500 = k\ [0.00500]^x[0.0125]^y}$	Where x and y, are the orders with respect to [A] and [B] respectively, and k is the rate constant.

This allows the simplification of the expression to read;

$\dfrac{Rate\ 1 = 1.00 = k\ [0.00500]^x[0.0250]^y}{Rate\ 3 = 0.500 = k\ [0.00500]^x[0.0125]^y} = 2 = 2^y$	Therefore y = 1, i.e., the order with respect to [B] is 1.

2. Mechanism #2

3. X is an intermediate

5.6

1. 1st order. The graph of ln[A] versus time is a straight line, consistent with the integrated rate law for first order reactions

2. 7 minutes (approx. since 'from graph')

3. 1.01×10^{-1} min^{-1}

Note: This value was calculated by taking the data across the full-time range of 25 minutes. Other, very similar (but different) values can be calculated by using smaller time ranges

6.1

1. (a) From propane to water
(b) 23.83 K
(c) Exothermic since energy is released during the combustion

6.2

1. (a) 7599 J
(b) 92.96 K

6.3

1. -124 kJ
2. -95 kJ
3. -1198 kJ
4. 0 (zero). Coincidentally, identical covalent bonds are broken *and* made so the endothermic (+ve) and exothermic (-ve) processes have the same magnitude and their sum = 0
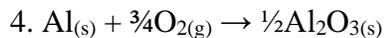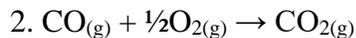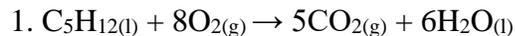
6.4

1. Ionic bonds. Intermolecular, hydrogen bonds

2. Endothermic, bonds or forces being broken.

3. They are polar, exothermic

6.5

1. $C_{(graphite)} + 1\frac{1}{2}H_{2(g)} + \frac{1}{2}Br_{2(l)} \rightarrow CH_3Br_{(l)}$

2. $4C_{(graphite)} + 4H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow CH_3COC_2H_{5(l)}$

3. $Na_{(s)} + \frac{1}{2}N_{2(g)} + 1\frac{1}{2}O_{2(g)} \rightarrow NaNO_{3(s)}$

4. During the formation of an element, "from its elements", i.e., from ITSELF, there is no change. For example; $Na_{(s)} ==> Na_{(s)}$ represents no change in any aspect, of which enthalpy is just one
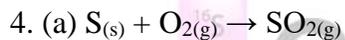
6.6

1. $C_5H_{12(l)} + 8O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(l)}$

2. $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$

3. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$

4. $Al_{(s)} + \frac{3}{4}O_{2(g)} \rightarrow \frac{1}{2}Al_2O_{3(s)}$

6.7

1. -84 kJ

2. -2005 kJ

3. (a) -852 kJ

(b) They are all zero

(c) +852 kJ

4. (a) $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$

(b) -297 kJ

5. (a) -126 kJ

(b) -124 kJ

(c) Answer (a), since it is calculated from formation and combustion data that are specific to the compounds involved. In part (b), the bond enthalpies are average values and therefore not necessarily specific to the compounds involved

7.1

1. Kc = 4.

All experiments yield the same value for K because each reaction is carried out at the same temperature

2. x = 0.845, so moles of acid = 0.155, alcohol = 1.155, ester = 0.845, water = 0.845

3. Kc = 13.1

4. Moles of HBr = 8.62

7.2

The relatively large amount of HI suggests that the equilibrium lies heavily to the right and side (products), and therefore the value of K will be relatively large

7.3

1. (a) Kp = 3.05

(b) The expression $Kp = \dfrac{\left(\dfrac{2x(1.5)}{1+x}\right)^2}{\left(\dfrac{1-x(1.5)}{1+x}\right)}$ leads to a math equation that is beyond the scope of AP chemistry but can be solved. Here it is simply important to see how the expression reached. (The actual value of x = 0.58 (or 58% dissociated) is consistent with a lower total pressure according to Le Châtelier's principle)

2. (a) Kp = 13.8

(b) Kp = 21.8

(c) The expression $Kp = 2.11 \times 10^4 = \dfrac{\left(\dfrac{2x}{2}\right)^2}{\left(\dfrac{1-x}{2}\right)^2}$ leads to a math equation that is beyond the scope of AP but can be solved. Here it is simply important to see how the expression reached. The actual value of x = 0.986 (or 98.6% dissociated) is consistent with the huge change in Kp at the higher temperature

3. 0.128

7.4

1. 1.72×10^{-11}

2. 2.36×10^{-5}

3. 0.0152 M, 4.75 g/L.

4. Precipitate forms since Q > Ksp and to reach equilibrium, the concentrations of the ions in solution must be reduced. That is achieved via the formation of a ppt.

7.5

1.(a) 1.26×10^{-5}

(b) 2.87×10^{-8}

(c) 6.32×10^{-9}

2. Addition of sulfate ions from an external source makes Q much larger than K. In order to restore equilibrium, Q must decrease in order for the value of K to be re-stored, and the reaction must shift to the side where solid barium sulfate is.

7.6

1. 4.5

2. (a) 6.7×10^{-6}

(b) 1.2×10^{-9}

(c) The high concentration of hydroxide ions in a solution of pH 11, causes the equilibrium to be shifted backwards (Le Châtelier's principle or Q v. K), and the solubility of the solid decreases. Essentially, this is a common ion problem.

8.1

1. Diagram B

2. Diagram C

3. Diagram A is a relatively dilute, weak acid; Diagram D is a relatively dilute, strong acid

8.2

1. 1.5

2. 12

3. 4.8×10^{-5}

4. 13.15

8.3

1. 1.82×10^{-5}

2. 4.86

3. Ethanoic acid since it has a larger Ka, meaning a greater degree of ionization

4. 2.37

5. 3.06×10^{-5}

6. 2.41×10^{-10}

8.4

1. 1.78×10^{-5}

2. 3.36

3. Methylamine since it has a larger Kb, meaning a greater degree of ionization

4. 11.45

5. 3.06×10^{-5}

6. 6.95×10^{-10}

8.5

1. 4.74

2. The best buffers are generally those with an approx. 1:1 ratio of acid and conjugate base (salt) components, since this allows them to absorb any additional acid and base equally well. Since the log of 1 is equal to 0, then the pH of the buffer is equal to its pKa

3. pH = pKa + log (deprotonated/protonated) = 7.6 + log (0.67/0.33) = 7.9

4. 4.62

5. 5.13

9.1

1. (a) Negative

(b) Positive

2. (a) 400 K. Higher temperature means greater disorder (entropy)

(b) A soft metal will have flexible, metallic bonding that induces more disorder than a very rigid solid like diamond

(c) The gas at the lower pressure, since the particles have more space to move in and as such can be more disordered. A gas at a relatively high pressure, means that the particles are packed into a relatively small space with relatively little room to move around. This leads to a lower level of disorder, i.e., a lower entropy

9.2

(a) E = +3.63 V; $Zn_{(s)} + F_{2(g)} \rightarrow Zn^{2+}_{(aq)} + 2F^-_{(aq)}$

(b) E = +0.14 V; $Sn_{(s)} + 2H^+_{(aq)} \rightarrow Sn^{2+}_{(aq)} + H_{2(g)}$

(c) E = +0.78 V; $Fe_{(s)} + Cu^{2+}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$

(d) E = +0.77 V; $H_{2(g)} + 2Fe^{3+}_{(aq)} \rightarrow 2H^+_{(aq)} + 2Fe^{2+}_{(aq)}$

9.3

(i) (Pt) | 1/2 $H_{2(g)}$ | $H^+_{(aq)}$ || $Ag^+_{(aq)}$ | $Ag_{(s)}$; +0.80 V
(ii) $Al_{(s)}$ | $Al^{3+}_{(aq)}$ || $Ag^+_{(aq)}$ | $Ag_{(s)}$; -1.66 V

9.4

Lower